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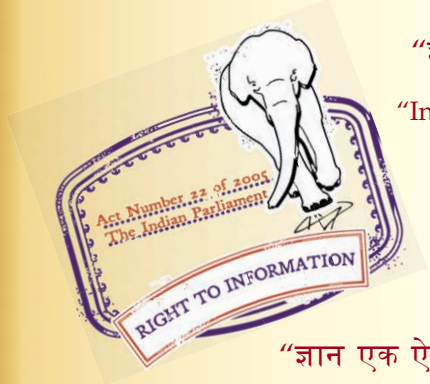

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Indian Standard

SPECIFICATION FOR ELECTRIC SOLENOID OPERATED ACTUATORS

(First Revision)

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SPECIFICATION FOR ELECTRIC SOLENOID OPERATED ACTUATORS

(First Revision)

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Indian Standard

SPECIFICATION FOR ELECTRIC SOLENOID OPERATED ACTUATORS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 25 September 1985, after the draft finalized by the Industrial Process Measurement and Control Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This Indian Standard was first published in 1978 and is revised to incorporate sampling plan and modification in respect of test requirements.

0.3 Electric actuators are electrically powered devices which are operated by some form of electric control system and are used to position control elements. These are mostly used to position control valves. They may also be used to position various other devices, such as dampers, burners, rhepstats, dry feaders, etc. The operating principle of solenoid operated actuators is described in 4.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard specifies the requirements and tests for ac (50 Hz) and dc electric solenoid operated actuators used for positioning of control valves.

NOTE — This standard covers only the requirements of actuators but not the valve body even though generally they are supplied together by the manufacturer.

*Rules for rounding off numerical values (*revised*).

1.2 It does not cover motor operated actuator which is covered by IS : 9334-1979*.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Ambient Temperature — The temperature of the surroundings at such a distance from the equipment where the effect of the heat generated by the equipment is negligible.

2.2 Armature Travel or Stroke — The distance travelled by the armature when it is pulled by the energized solenoid.

2.3 Pull-in-Force — The force to be applied on the armature to pull it in completely to change the valve position.

2.4 Response Time — The time taken by the actuator from the application of the step signal to the solenoid till the time armature is pulled in.

2.5 Maximum Overshoot — The maximum initial overshoot permissible.

2.6 Number of Cycles — The number of cycles taken from the first overshoot till the plunger settles down.

3. TYPES

3.1 Depending on the motion of the actuator armature and the effective movement of the control valve, the electric solenoid operated actuator shall be one of the following types:

Type 1 Linear electric solenoid operated actuators.

Type 2 Rotary electric solenoid operated actuators.

4. PRINCIPLE

4.1 Electric solenoid operated actuator basically consists of an electromagnet and a movable armature. One end of the armature (yoke) is connected to the device to be positioned. Whenever there is a deviation in the set value of the parameter under processing, the control system energizes the electromagnet and thereby the armature is pulled in positioning the device appropriately. The actuation may be directed by

*Specification for electric motor operated actuators.

solenoid or pilot operated which shall consist of a solenoid allowing the process fluid to operate the valve in turn.

5. CONSTRUCTION

5.1 Electromagnet — This is a simple solenoid. The two ends of the solenoid are connected to the control system which energizes the solenoid in the necessary and appropriate conditions.

5.2 Armature — This is a cylinder made with a material of high permeability. One end is free and is kept coaxially in the solenoid and the other end is linked to the device to be positioned.

5.2.1 In the case of linear electric solenoid operated actuators, the armature stem (yoke) is directly coupled to the device to be positioned.

5.2.2 In the case of rotary electric solenoid operated actuators, the mechanical principle of inclined plane is made use of to convert straight pull to a rotary motion. In these actuators, as the armature is supported by three ball bearings that travel around and down in three inclined groves, the armature is forced to rotate by a cam action.

6. GENERAL REQUIREMENTS

6.0 The solenoid operated actuators shall be classified as follows:

a) General purpose (for use inside rooms),

b) Water-tight/proof (shall be conforming to IS : 2147-1962*), and

c) Flame proof (shall be conforming to IS : 2148-1981†).

6.1 Switching Mechanism — In order to prevent excessive heating when solenoid is energized over extended periods of time, switching mechanism may be incorporated in the design to insert a resistor in series with the solenoid circuit when the armature reaches its energized position. This will limit the continuous current flow to a safe value.

6.2 Manual Override — Manual override may be provided for manual opening of the solenoid valve in order to override automatic control or in the event of power failure. This may be provided either with a wheel or lever.

6.3 Manual reset may be provided to reset the solenoid valve after it has been energised. After manual resetting the valve shall be ready for subsequent operation.

*Degrees of protection provided by enclosures for low voltage switchgear and controlgear.

†Specification for flameproof enclosures of electrical apparatus (*first revision*).

6.4 Coil Encapsulation — The coils shall be encapsulated with tough epoxy resin and shall be highly resistant to shock, moisture, oil and chemicals. The coil insulation shall correspond to at least Class E insulation (*see* IS : 1271-1958*).

6.5 Chattering — The actuators shall be free from chattering during operation.

7. TECHNICAL REQUIREMENTS

7.1 Ambient Temperature — The ambient temperature shall normally be between 15°C and 55°C.

7.2 Temperature-Rise — The maximum temperature of the coil shall not exceed 105°C, for class A insulation, 120°C for class E and 130°C for class B insulation, 155°C for class F insulation and 180°C for class H insulation.

7.3 Pull-in-Force — Pull-in-force shall be from a few centinewton to a few deca-newton.

7.4 Armature Travel or Stroke — The manufacturer shall specify the armature travel/stroke.

7.5 Duty Cycle — The actuator shall be of continuously energized type or intermittent duty type. For the latter type, the manufacturer shall specify the duty cycle.

NOTE — Heating is considerably greater when solenoid operated actuators are energized continuously than when they are operated intermittently.

7.6 Response Time — The manufacturer shall specify the response time.

7.7 Supply Voltage — The actuators shall be designed for operation on:

a) 24, 48, 110, 240 and 415V ac, at 50Hz, and

b) 6, 12, 24, 48 and 110 V, 220 V dc.

7.7.1 *Tolerances* — The solenoid operated actuator shall be so designed as to operate under the following conditions of the supply system:

a) Voltage — ±10 percent.

b) Frequency — ± 3 percent.

*Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.

7.8 Holding Voltage — The minimum holding voltage shall be 70 percent of the rated supply voltage.

7.9 Power Drawn by the Solenoid — The power drawn by the solenoid in the holding and in-rush condition shall be specified to facilitate the requirements of the controlled equipment.

7.10 Insulation Resistance — The insulation resistance between the coil winding and the enclosure, when measured at 27°C ± 2°C and 65 ± 5 percent relative humidity shall be as given below:

Actuator Rated Voltage V	*Test Voltage* V (dc)	*Insulation Resistance* MΩ, *Min*
6, 12, 24, 48 dc 24, 48ac	200±20	10
110, 220 V dc 110, 240, 415 ac	500±50	100

7.11 Voltage-Proofness — The coil shall be able to withstand the high voltage test as specified in **10.5**.

7.12 Cable Entry — The cable entry to take out the leads shall have minimum diameter of 15 mm.

7.12.1 The terminal housing should meet the specified degree of protection in accordance with IS : 2147-1962* and the specified type of enclosure in accordance with IS : 2148-1981†, as applicable.

8. PACKING AND MARKING

8.1 Packing — Actuators shall be packed in wooden or other suitable containers so as to avoid any damage during transportation.

8.2 Marking — The following shall be clearly and indelibly marked on the actuators :

a) Operating voltage,

b) Power rating,

c) In-rush current, and

d) Pull-in-force.

8.2.1 The actuator may also be marked with the ISI Certification Mark.

*Degrees of protection provided by enclosures for low voltage switchgear and controlgear.

†Specification for flameproof enclosures of electrical apparatus (*first revision*).

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

9. INFORMATION TO BE SUPPLIED BY THE MANUFACTURER

9.1 The manufacturer shall supply in a booklet, detailed operating instructions, schematic diagram, pracautions in use and lists of components, etc.

10. TESTS

10.1 Type Tests — The following shall constitute type tests and shall be carried out in the sequence given below:

a) Insulation resistance test (**10.4**),
b) High voltage test (**10.5**),
c) Test for maximum temperature of coil (**10.6**),
d) Holding voltage test (**10.7**),
e) Pull-in-force test (**10.8**),
f) Armature travel test (**10.9**),
g) Power consumption test (**10.10**), and
h) Damp heat (cycling) test (**10.11**).

10.2 Acceptance Tests — The following shall constitute acceptance tests and shall be carried out in the sequence given below:

a) Insulation resistance test (**10.4**),
b) High voltage test (**10.5**),
c) Test for maximum temperature of coil (**10.6**),
d) Holding voltage test (**10.7**),
e) Pull-in-force test (**10.8**),
f) Armature travel test (**10.9**), and
g) Power consumption test (**10.10**).

10.2.1 *Sampling Plan* — A recommended sampling plan and the criteria for acceptance of the lot are given in Appendix A.

10.3 Routine Tests — The following shall constitute routine tests and shall be carried out in the sequence given below:

a) Insulation resistance test (**10.4**),

b) Holding voltage test (**10.7**), and

c) Power consumption test (**10.10**).

10.4 Insulation Resistance Test — The insulation resistance measured between both the leads of the solenoid connected together and the body of the actuator under the test conditions and with a test voltage as specified in **7.10**, shall not be less than the values specified in **7.10.**

10.5 High Voltage Test — The provisions of **5.5** of IS : 9249 (Part 1)-1979* shall apply.

10.6 Test for Maximum Temperature of Coils

10.6.1 The temperature of the coil shall be measured by the self-resistance method, using a resistance measuring bridge. The coil shall be kept energized to its rated voltage for a period of time sufficient for the temperature to rise to a constant value. In practice this condition is reached when the variation does not exceed 1°C per hour.

10.6.2 The temperature is calculated by using the formula:

$$R_T = R_0 [1 + a (t_2 - t_1)]$$

where

R_T = final resistance of the coil,

R_0 = resistance of the coil at room temperature,

a = temperature coefficient of resistance of the material of the wire,

t_2 = final temperature, and

t_1 = initial temperature.

10.6.3 The temperature measured as in **10.6.2** shall satisfy the conditions specified in **7.2.**

10.7 Holding Voltage Test — For the purposes of this test it shall be initially verified that the electric solenoid operated actuators shall

*Specification for safety requirements for indicating and recording electrical measuring instruments and their accessories : Part 1 Common safety requirements for instruments.

operate correctly at all values of supply voltage between 85 percent and 110 percent of its rated value. The electric solenoid operated actuators shall be tested to verify its conformity to the requirements of **7.8**. The solenoid shall be energized to its rated voltage so that it operates the mechanical body it is intended to actuate. The voltage shall be gradually reduced and the mechanical body shall not be de-actuated till 70 percent of the rated voltage is reached.

10.8 Pull-in-Force Test — The pull-in-force shall be measured by a suitable method as agreed to between the manufacturer and the purchaser.

10.9 Armature Travel Test — The specified value of armature travel (*see* **7.4**) shall be verified at the rated voltage of the solenoid as compared to the null position when the solenoid is completely de-energized.

10.10 Power Consumption Test — As specified in **7.9**, the power drawn by the solenoid in (a) holding condition and (b) the in-rush condition shall be declared by the manufacturer.

The steady current at full rated voltage, in the holding condition of the solenoid, with the complete actuator mechanism in position as in actual operating conditions, and the value of the in-rush current when the supply is switched on shall be measured by ammeters.

The resistance of the solenoid shall be suitably measured using a resistance measuring bridge. Suitable care shall be taken that self-inductive effects are minimized.

The power consumption shall be calculated from the above measured values.

10.11 Damp Heat (Cycling) Test — This test shall be performed according to the details specified in IS : 9000 (Part 5/Sec 1)-1981*.

The number of conditioning cycles shall be 6.

After completion of this test, the solenoid operated actuator shall be tested for conforming to **10.7**.

*Basic environmental testing procedures for electronic and electrical items: Part 5, Section 1 Damp heat (cyclic) test.

APPENDIX A

(*Clause* 10.2.1)

SAMPLING OF ELECTRIC SOLENOID OPERATED ACTUATORS

A-1. SCALE OF SAMPLING

A-1.1 Lot — In a consignment, all the actuators of the same type and rating manufactured from the same raw material under similar conditions of production shall be grouped together to constitute a lot.

A-1.2 The number of actuators to be selected from each lot shall depend upon the lot size and shall be in accordance with col 1 and 2 of Table 1.

A-1.2.1 These actuators shall be selected from the lot at random. In order to ensure the randomness of selection, procedure given in IS : 4905-1968* shall be followed.

TABLE 1 SAMPLE SIZE AND PERMISSIBLE NUMBER OF DEFECTIVES

(*Clauses* A-1.2 *and* A-2.1)

LOT SIZE	SAMPLE SIZE	PERMISSIBLE NO. OF DEFECTIVES
(1)	(2)	(3)
Up to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 to 500	20	1
501 and above	32	2

A-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

A-2.1 The actuators selected at random according to col 1 and 2 of Table 1 shall be subjected to all the acceptance tests. The actuator failing to satisfy any of these requirements shall be considered as defective. The lot shall be considered as conforming to the requirements of this standard if the number of defectives found in the sample is less than or equal to the corresponding permissible number given in col 3 of Table 1, otherwise the lot shall be rejected.

*Methods for random sampling.